METHOD OF SELECTIVE SEPARATION OF SEMICONDUCTING CARBON NANOTUBES, DISPERSION OF SEMICONDUCTING CARBON NANOTUBES, AND ELECTRONIC DEVICE INCLUDING CARBON NANOTUBES SEPARATED BY USING THE METHOD

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a Divisional of U.S. application Ser. No. 13/282,783, filed on Oct. 27, 2011, which claims priority to the benefit of U.S. Provisional Patent Application No. 61/408,805, filed on Nov. 1, 2010, in the US Patent and Trademark Office, the entire contents of each of the above-referenced applications are hereby incorporated by reference.

BACKGROUND

[0002] 1. Field

[0003] Example embodiments relate to a method of selectively separating semiconducting carbon nanotubes (CNTs) by using a polythiophene derivative, a dispersion of semiconducting CNTs, and/or an electronic device including semiconducting CNTs separated by the method.

[0004] 2. Description of the Related Art

[0005] Carbon nanotubes (CNTs) may be anisotropic and may have various structures. For example, CNTs may be single-walled, multi-walled, or bundled. CNTs may have diameters of nanometers.

[0006] CNTs may have semiconductor or metallic characteristics according to a pattern in which hexagonal honeycomb-like rings of carbon atoms are coiled. CNTs may have different energy gaps according to their diameters. CNTs may have quasi-one-dimensional energy spectra and exhibit unique quantum effects.

[0007] CNTs may be used for various purposes and be sorted either metallic CNTs or semiconducting CNTs according to their uses.

[0008] For example, semiconducting CNTs may be used in thin film transistors, including thin film transistors operating at room temperature.

[0009] General methods of separating and/or purifying semiconducting CNTs may have low separation and/or purification yields and may require post-processes, for example, to remove additives. As a result, general methods of separating and/or purifying semiconducting CNTs can be difficult to apply in mass-scale production.

SUMMARY

[0010] Example embodiments relate to methods of selectively separating semiconducting carbon nanotubes (CNTs).

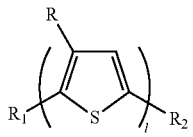
[0011] Example embodiments relate to CNT dispersions including a high-yield of semiconducting CNTs.

[0012] Example embodiments relate to electronic devices including semiconducting CNTs separated by using the foregoing methods.

[0013] According to example embodiments, a method includes: dispersing carbon nanotubes in a mixed solution containing a solvent, the carbon nanotubes, and a dispersant, the carbon nanotubes including semiconducting carbon nanotubes. The dispersant may include a polythiophene derivative including a thiophene ring and a hydrocarbon sidechain linked to the thiophene ring, wherein the hydrocarbon sidechain includes an alkyl group containing a carbon number of 7 or greater, and the hydrocarbon sidechain being regioregularly arranged, and selectively separating the semiconducting carbon nanotubes from the mixed solution.

[0014] The polythiophene derivative may be represented by Formula 1 below:

Formula 1



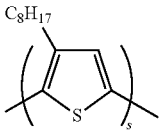
[0015] wherein R is a C7 to C50 alkyl group;

[0016] R1 and R2 are each independently one of hydrogen, halogen, methyl, and halomethyl; and

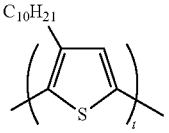
[0017] I is an integer from 1 to 40,000, and/or an integer from 1 to 10,000.

[0018] The polythiophene derivative may be represented by one of Formulae 2, 3, and 4 below:

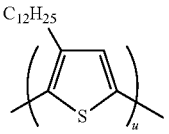
Formula 2



Formula 3



Formula 4



[0019] wherein s, t, and u are each independently an integer from 1 to 40,000.

[0020] The polythiophene derivative may be represented by one of Formulae 5, 6, and 7 below:

Formula 5